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THE PHYSIOLOGICAL ARGUMENT AGAINST REALISM

THE chief argument against realism is that which has lately been called the physiological argument. It is based upon the generally recognized fact that our sensations come to us through the mediation of our sense organs. Without proper anatomical equipment and its proper physiological functioning there would be no sensations. Sensations are thus variables, dependent on the variations of physiological processes. Hence, it is argued, the qualities present in sensation can not be qualities of independent objects, but must be merely mental in their nature. As Locke puts it, they are ideas produced in us; they "are in truth nothing in the objects themselves," or rather "there is nothing like our ideas existing in the bodies themselves. They are in the bodies, we denominate from them, only a power to produce those sensations in us."[1]

Now it is probable that the mere fact that we are aware of sense qualities only when certain physiological processes are going on would never have led any one to suppose that these qualities do not belong to independent objects. If we always got the same sensations from the same object no matter what our state of body or our moods might be, and if we had reason to suppose that these sensations are exactly similar to those that other persons experience, the fact that these sensations are mediated by physiological processes would perhaps never have aroused any suspicion as to the subjectivity of the qualities sensed. But such is not the case. Only a little examination of our experience is necessary to show that sometimes "the same body which appears cold to one hand seems warm to another," as Berkeley puts it. "Again, it is proved that sweetness is not really in the sapid thing, because the thing remaining unaltered the sweetness is changed into bitter, as in case of a fever or otherwise vitiated palate."[2]

[1] "Essay concerning Human Understanding," Book II., Chapter VIII., §§ 14, 15. Of course Locke limits this statement to what he calls "secondary qualities."

[2] "Treatise concerning the Principles of Human Knowledge," § 14.

Now if we can sense such different qualities in one and the same object at the same time, or at different times when we have no reason to think that the object itself has changed in the meanwhile, it is obvious that we have to suppose that all these seemingly incompatible qualities are united in the object, or else to suppose that sometimes at least our senses falsify the qualities of objects which they purport to give. The former alternative is unpalatable to us because we are prone to think that reality must not be self-contradictory. If the object really has color, it must choose which color it is to have in any part of it at any time. It must not have all the colors of the rainbow all over it all the time. If this were possible, then there is no reason why every object should not have every quality, every size, every speed of motion, and so on. Our senses would be sieves, which would each let only one quality through at any time from any one part of the object into the experience of any single person. Such a theory would be tenable if one cared to say that the law of contradiction applies not to real objects, but only to so much of the real objects as we can experience at any one time. The law would thus be the law of the sieve and of what in consequence is sifted through, but not the law of what lies above the sieve. But such an interpretation of the law of contradiction is repugnant to common sense. We tend to apply the law to reality as a whole, as well as to those aspects of reality which we can at any time perceive.

Hence the only resort is to maintain that the senses are deceptive. But if they deceive us, how can we know that they do not always deceive us? *Falsus in uno, falsus in omnibus* is a maxim we apply to them, and we get thus the doctrine of the entirely subjective character of our sensations.

Having thus obtained the doctrine, we proceed to explain the falsification of the senses by the fact that our sensations are dependent upon physiological processes—a fact which, as I observed above, would probably never have awakened doubt touching the objective character of sense qualities if that fact had stood alone. This makes it advisable to examine the physiological argument by itself, and thus to see whether that argument by itself has any force against realism.

As we have seen, the physiological argument starts with the fact of the correlation of our experience with our physiological processes. But there is another fact in our experience that is equally indubitable, and that fact is that we perceive objects which, until we begin to get sophisticated, are regarded as real and independent of our perceiving. Unless we keep in touch with this naïve experience in which there are real and independent objects presented, we can have

no psychophysical correlation—no correlation between objects perceived, on the one hand, and real brain events, on the other. If the objects perceived are reduced to merely subjective processes, then the brain events upon which, according to the law of psychophysical correlation, they depend, must in consistency be interpreted as merely subjective processes also. For, of course, we have no better evidence of the existence of brain events than we have of other "external" objects.[3] The fact is that we know the one in exactly the same way as we know the other.

But suppose that we grant this, and yet try to take away the realistic implications involved in the admission by saying that the object which we see and the nerve and brain which mediate the seeing are all subjective, all ideal. Does not this put idealism on a better footing? I think not. The processes of nerve and brain have the disadvantage of not existing as objects of consciousness every time that we have perceptions through their mediation. If we were always conscious, first of brain event, and then of a perception of some "external" object dependent on that event, we probably could, if we pleased, state the fact of psychophysical correlation as a fact of constant sequence among actually present subjective processes, without prejudice to the law of correlation. But perceptions have a way of appearing without the previous appearance of their corresponding brain events. Hence if we are to accept the law of correlation as valid, the brain events must be admitted to be real *without being present in consciousness.* Thus the law of correlation may not be interpreted in such a way as to derealize the unperceived physiological processes. Either that law is true and the brain events corresponding to perceptions are real though not perceived, or else the brain events are not real and then the law is not true. To start with the reality of brain events, and on this reality to build up a theory which denies this reality, is to play fast and loose with logic. We may, therefore, say that idealism can not without manifest contradiction build on the law of correlation a theory which involves the non-existence of actual brain events corresponding to perceptions; for the law of correlation is a true law only if there are actual brain events, unperceived, corresponding to perceptions of "external" things.

Professor Strong has attempted to meet this difficulty which confronts the idealistic theory by substituting "possible perceptions" of the brain events for the actual brain events which realism postulates. The result is that before (or perhaps along with, or even a

[3] See Professor Fullerton's admirably lucid chapter on "The Metaphysics of the 'Telephone Exchange'" in his "System of Metaphysics," p. 342 ff.

little after) every perception of an "external" object there is placed a "possible perception" of a brain event. In place of a real correlation between two real things, there is thus put a correlation between a figment and a reality. This reminds me of an invitation I once received to join a party of little tots in a journey to the moon. I pointed out that I had no vehicle for the purpose. I was told that my chair would do. I then pleaded that I did not find myself moving in the desired direction. I was told that I could play that I was moving. Professor Strong *plays* that there is a possible perception of a brain event corresponding to actual perceptions of trees and stars.

But Professor Strong would perhaps think that this is not quite fair. He would say that the perception of the brain event is *really* possible. I am afraid, however, that the word "possible" is rather confusing. Under other conditions than those now prevailing when I see a tree, it might be possible to get a perception of a brain event that was occurring in my own cranium, but the *actual* perception of the complex brain event corresponding to my present entire experience would alter this experience very considerably. Hence the "possible" perception on which the "real" present perception depends is *im*possible under just the conditions under which the real perception is possible. We might as well, therefore, say that every "external" perception is preceded by what, under the conditions under which it appears, is an impossible perception of a brain event making that "external" perception possible! This certainly explains the "external" perception and maintains the law of psychophysical correlation very beautifully.

Anything is possible when certain conditions for its actuality are given and the remaining conditions are ignored or are unknown. Thus when I have thrown dice and still hold the cup over the dice, I may say it is possible that I have thrown double-six. The assertion of such a possibility is justified only on the basis of certain actual facts which are known; that is, on the basis of a reality of which we know something and of which we do not know everything. *Possibility presupposes reality* and is a category which we use when we assert our knowledge of certain aspects of this reality and either ignore or are ignorant of the remaining aspects. Possibility is itself possible only because of our ignorance. Now to take possibility of perception as the *meaning of reality*, rather than to make the possibility of perception depend on a reality which might be perceived if the conditions were favorable, and to do this merely that one may maintain an idealistic theory, is as violent and preposterous a procedure as the bloodless annals of philosophy have ever recorded,

and its violent character is not abated by the fact that there is historical precedent for it.

But does not the fact that the object of vision arises on condition of certain processes in the brain make the object of vision in some sense less real than the brain which conditions it? How can the object be prior to the process in the brain so as to initiate the process and also subsequent to the process as its result? Can the seen tree be the same tree as that which causes the physiological process on which the seeing of the tree depends? Is not this to make the thing the cause of its own cause? It is—*if* we assume at the outset that the thing perceived is merely a "state of consciousness," which of course can not arise till there is a consciousness of which it is the state. But if we distinguish between *sensum* and *sentire* and *sensibile*,[4] then the difficulty vanishes. The *sentire* may be the effect of the physiological process, and yet the *sensum* may be the same as the *sensibile* which initiated the physiological process on which the *sentire* depends. Consciousness arises as the correlate of physiological functioning, and when it arises it does not produce its object. What object shall be present to it depends on the total situation within which the awareness occurs. If the situation contains, as a part of its factors, a tree acting through light waves on the retina, the optic nerve, and the brain, then why may not the tree rather than something else be the object of the awareness that arises in correlation with the brain activities induced? We have no right to determine *a priori* what under any given conditions shall be the object of awareness that arises under those conditions, any more than we have a right to determine *a priori* what shall be the effect of reducing the temperature of water to zero centigrade. We have to accept facts as we find them, and this humiliating prescription holds good as well in epistemology as in physics.

But it is argued that we are not obliged to accept contradictions, and that there is a contradiction in terms when it is stated that we can directly see the tree which causes the disturbances in the brain, on which our vision depends. There are too many things *lying between* the tree and the vision to make it possible for the vision to be *immediate*. We must, therefore, examine this contention. But first let me try to state the facts in the case under con-

[4] See my recent article, "Prolegomena to a Tentative Realism," in this JOURNAL, Vol. IV., p. 449. My attention has recently been called to the fact that Professor Montague's article on "Current Misconceptions of Realism," which appeared in this JOURNAL, Vol. IV., p. 100, had anticipated mine on several points. I should have noted this fact in my previous article, for I had read Professor Montague's paper; but I did not have it in mind when I was writing.

sideration in such a way that no contradiction seems to result, and then we shall be in a position to see the fallacy of those who try to make out a contradiction where no contradiction is.

The law of psychophysical correlation can best be stated in mathematical terms, using the word "function" in a mathematical sense. A "function" in mathematics, as every one knows, is a quantity that varies as some other quantity varies. Let us now take a number of functional equations related in a peculiar way:

$A=f(B)$, $B=f(C)$, $C=f(D)$, $D=f(E)$, $E=f(F)$; therefore $A=f(F)$.

This is a series of equations which tells us the way in which A varies, ending with the statement that it varies with F. But it does not tell us *what* A is. A may be anything and F may be anything so far as the formula goes. Anything else than the fact that A varies with B, C, D, E, and F must be learned from some other source than the formula. But when we apply the formula to facts of experience which the formula fits, the final equation, $A=f(F)$, holds good.

Now when this functional formula is applied to the case before us, F is the *sensibile,* say a tree, separated from the *sentire* by a greater or less interval of time. The *sentire,* or awareness, does not find its expression in the formula, but the *sensum* does; the *sensum* is the A of the formula, and for the realist this *sensum* is the same as the *sensibile;* it is the *sensibile in a different relation* from that in which it stands when it is regarded as the initiator of the brain processes. It is the *sensibile* as object of the *sentire.* The *sensibile,* as initiator of the brain processes, is the independent variable or the "constant" of the equation, and its variations condition the variations of E (light waves), D (retinal stimulation), C (excitation of the optic nerve), B (cortical disturbance, or "brain event"), and A (*sensum,* the tree as object of awareness). The tree, as reality in the order of nature, acts on other objects in that order, viz., light waves, retina, optic nerve and brain, and then it appears in a new relation, as an object of awareness. In other words, a thing, in the variations it produces on light waves and bodily organism, is the condition of the variations which this same thing undergoes in another relation, namely, as object of an awareness which is correlated with a certain process in that organism. There is surely no contradiction in such an application of the functional formula.

One word is necessary on the above-indicated unvaryingness of the awareness. Awareness is the name of an abstracted feature of a concrete fact, namely, the fact of experience, or awareness-of-objects. *This concrete fact* varies, but when we examine the nature of its vari-

ations, we find that what changes is the complex of objects, not the awareness. We have here something parallel to the change that is undergone in an object whose size alters while its color remains the same. The concrete object changes, but not its abstract characteristic of color. So experience, the concrete fact under consideration, changes, but when we look closely into its changes, we find that the *objects* of experience change, but the awareness remains the same in all the changes of experience. At one time there is awareness of one set of objects, at another time there is awareness of another set. Now there are many objects, now there are fewer objects: the "field of awareness," *i. e.*, the range of objects, expands and contracts, just as an object expands and contracts when its size varies. But just as this enlargement and contraction do not make the color of the object change, so the expansion and diminution of the field of experience do not make the awareness change.

Is consciousness, therefore, a function of the bodily organism? Yes and no. Yes, in that, so far as we can judge from our experience, there is consciousness only when certain brain states occur. The *fact* of consciousness is a "function" of the bodily organism in the sense that this fact does not exist unless certain changes take place in the brain, and it exists when these changes do occur. But when changes of a certain kind thus occur, changes of the brain *within the limits of this kind* do not occasion changes in consciousness. The only changes that consciousness undergoes, if we may speak of them as changes *of* consciousness, are changes from existence into non-existence, and *vice versa*. The question with which this paragraph began must, however, be answered negatively, if "function" be taken in the stricter sense; for, as we have seen, many changes are possible in the brain which do not in any way result in a change of consciousness, in the only sense in which there is any change of consciousness. That is to say, many changes in the brain processes leave consciousness unchanged, while the *objects* of consciousness change. It is for this reason that in the functional formula given above the A is not to be interpreted as consciousness, but as object of consciousness.

Now our functional formula, applied to the relation of the real thing to the perceived thing, still leaves a difficulty on our hands. How can what no longer exists *in re* still exist *in sensu*, if it be the same thing in either case? This question is forced on us by the fact that our perception is always at least slightly belated. As Professor Strong puts it, "The time needed for light rays to pass from the object to the eye and call forth the organic process to which perception corresponds has this result, that we perceive a slightly earlier

state of the object than that which coexists with the perception.''[5] In the case of the vision of a star, ''The starlight I see left the star years and years ago.''[5] The star that I see, therefore, must exist in the same state at two different times many years apart, if the star I see is the same as the real star in the order of nature.

Now the question how that which exists *in re* can also exist subsequently *in sensu* can be answered differently according to the different possible meanings to the question. If the question asks for the *process* by which the past thing becomes present object, the answer is given when our formula is interpreted in terms of our present problem. The past reality can be seen now and not before, because the intermediate functions are temporal functions and may require a long time to run their course.

But the question may mean, How can you escape the contradiction of saying that the same object existed long ago *in re* and now exists *in sensu?* How can numerically the same state of the object exist at two different times? I answer that contradiction exists only when ''diversities are attached to one unyielding point assumed, tacitly or expressly, to be incapable of internal diversity or external complement.''[6] The star as an object in the order of nature is identically the same star as that which is the object of consciousness, but the same star *in different relations,* and what is true of it in one relation may not be true of it in another relation, even though in both relations its position in time be involved. If the star were a vacuous identity, ''incapable of internal diversity or external complement,'' of course this would be impossible. But as it is a thing that can stand in different relations, there is no contradiction. It is sufficient for the philosopher to state the facts in such a way that no contradiction results. He is not called on to explain everything he finds, except in so far as explanation consists in a statement of general principles. The principles themselves do not have to be explained. The general principle, in our case, is that the special time relations of things to each other differ according as these things are taken in their natural order or in their order as objects of immediate consciousness. So long as the two orders are distinguished, no contradiction is involved in considering the special time relations as different in the two orders.

[5] This JOURNAL, Vol. I., p. 521. It was Professor Montague who brought Professor Strong to consider the disparity between the time of perception and the time of object perceived. But Professor Montague uses this time-disparity as an argument against what he calls a "telepathic theory of perception." I conceive it to be a proof of the theory, although I do not like the name with which he dubs it.

[6] Bradley, "Appearance and Reality," pp. 566, 567.

Every theory which admits the reality of time, whether as merely subjective in the Kantian sense, or as objective in the popular sense, must admit that the real time of an occurrence may differ from its apparent time. It is a principle without which we can not harmonize our experiences. The realism which I am studying does not make the difficulty; it solves the difficulty by pointing to a difference of relation which makes the thought of such a difference in time logically consistent, without making necessary the duplication of the object which thus has different relations. So far as I can see, therefore, we may consistently maintain that it is the same star which I now see and which existed perhaps a hundred years ago. It existed *in rerum natura* when I was not aware of it, and my awareness of it arises after a long interval. When this awareness does arise, it does not manufacture a counterfeit presentment of the obsolete star; neither does it call back to renewed life in the order of nature the extinct orb. The star, gone in the order of nature never to return *in that order,* returns *in another order,* the order of immediate objects of consciousness. In that order it takes the same date as that occupied by objects which in the natural order are long subsequent to the star as a dated fact in the natural order. Let me illustrate this difference of orders by referring to the fact that Wilhelm II as head of the German Empire far outranks Professor Harnack, who is merely a professor in a state university, and is thus separated from Wilhelm by many intervening principalities and powers. But in the order of historical scientific critics of the Apostles' Creed, Professor Harnack is perhaps *facile princeps,* and Wilhelm is faintly discernible in the lower ranks, among the unnamed subjects of his imperial realm. The first is last and the last is first. So, likewise, the same object can be differently disposed in time in the two orders of nature and of immediate presence to consciousness; for there is a natural order and there is a spiritual order.

But the question, How can a *past* reality be now *present* as an object of consciousness? may appear to have still another meaning. It may mean, How can consciousness be immediately aware of temporal things which do not belong to its own time?

Here emphasis may be laid on "immediately," and the question may mean, How can we be immediately aware of what is not immediately present? The answer is that "immediately" is here used in two senses. The first "immediately" brings out the fact that the object is actually an object of consciousness, standing *in propria persona* before consciousness, neither is there any daysman betwixt them, that might lay his hand on them both and bring them to-

gether by external arbitration. The second "immediately" is temporal: the object in the state in which it is now perceived belongs, as an object having a fixed place in the time order of nature, to the past, and there is an interval between the place it occupies in that order and the place that the consciousness of it occupies. The star may be an immediately present object of consciousness, but an object which we may be aware of as having existed "out of consciousness" long before it became an object of consciousness—nay, we may even have reasons for supposing that it no longer exists "out of consciousness."

There may be another ambiguity in the term "immediately present," which is responsible for the difficulty in accepting the immediate presence in consciousness of an object, like a star, which we have reasons for believing existed long before our consciousness became aware of it. To be "immediately present" to consciousness may mean to be present without having been brought to consciousness by any intermediating processes, or it may mean to be present in the unique way in which my hand is present in consciousness when I open my eyes and look at it. When I shut my eyes, my hand as a visible object is present in consciousness through a representative image; it is not immediately present, but representatively so. When I open my eyes and look at the hand, it is immediately present. But in either case there are physiological processes that mediate the presence of the object; in the one case as an immediate object, in the other case as a represented object. Thus an object can be both immediately present in consciousness and mediatedly so, just as a person may be immediately present in a police station and yet have been brought there by certain mediating agencies. This fact, however, is often overlooked in arguments against realism. It is assumed that the mere fact that no object ever presents itself to consciousness without the intermediation of physiological processes renders impossible the immediate presence of any object to consciousness.

But the question, How can a past reality be now present as an object in consciousness? may be asked with still another meaning, and therefore with still another required answer. It may mean, *Why* should there be an awareness now of objects that in time existed before the awareness? I give it up. But I will return the riddle. Why should there be *redness, roughness, rats?* Given a world in which such things are, we can laboriously trace the processes by which they came to be, arising in sequence on other things that have been. But if nothing is given, and then I am asked to explain how or why these things are brought into existence, I prefer to

pass the question on to some orthodox professor of systematic theology.

All I know about the matter is that there *is* such an awareness and that we must accept the fact that *we constantly have immediate awareness of what in the natural order of timed things is not dated in the immediate present.* Immediate presence in consciousness and existence in the order of nature at the same time that consciousness exists are two different facts that we have to distinguish, just as we distinguish any other different facts. It is an old saying that most of the difficulties in philosophy are due to ambiguities in the words we employ in our philosophical reasoning. This is a case in which that saying applies. When we make the proper distinctions we find that the alleged contradictions of realism which we have been considering vanish; there is left only the existence of ultimate facts to be accepted or not as the evidence for them decides. There is no logical absurdity in the realistic doctrine on this point.[7]

If this has been made clear, we are in a position to see that the physiological argument which is directed against the realist returns as a boomerang against the idealist. Professor Strong, one of the present protagonists of antirealistic philosophy, admits, as we have seen above, that if we accept the facts of physics and physiology, we must admit that "we perceive a slightly earlier state of the object than that which coexists with the perception." This admission, instead of involving the *reductio ad absurdum* of realism, turns out to be a means of reducing idealism, at least of Professor Strong's kind, to absurdity. For we must remember that Professor Strong says that he has never been able to distinguish "the perception of a tridimensional book from the book itself."[8] If he can not make this distinction, how in the world can he speak of perceiving a slightly earlier state of the *object* than that which coexists with the *perception?* Here the object that is perceived is surely distinguished from the perception and is made to antedate the perception. The fact is that the physiological argument *demands* that the object perceived should exist before the perception, and therefore that *it should be distinguished from the perception.*

[7] If we had the time here, it would be desirable to take up the various points involved in the distinction between the time order of nature and the time order of objects as immediately present to consciousness. I wish here merely to say that the realism we are studying does not deny the *reality* of the latter time order or of such objects as have a place only in that time order—such objects as images of past realities in the natural order. Everything is real in its own way, whether it exists in the one time order or in the other. Again, realism does not assert that there are *two times, separate from each other.* But this is too much of a problem to be taken up in this article.

[8] This JOURNAL, Vol. I., p. 547.

Professor Strong may not reply that the object perceived, which exists before the perception of it, is merely a "possible perception" which some Psyche might have had if she had been favorably situated to get it; for he has assured us that "in the endeavor to adjust the facts of experience to one another," you must not "be led to the conclusion that objects are *beyond* that of which you are immediately conscious, without having lost contact in some way with the firm ground of experience from which you set out."[9] Surely a possible perception *is* beyond that of which we are immediately conscious; hence the object can not be a possible perception. It is just the perception itself, and yet it precedes the perception itself! No wonder that Professor Strong admits "that there is an apparent antinomy here." The thing that one can not help wondering at is that he should say of the theory which gets him into such an antinomy: "The beauty of the panpsychist theory is that it enables us to clear it up quite completely."[9] There is more contradiction to the square inch here than Professor Strong has succeeded in showing to exist in the whole reach of realism. Although there is no distinction between perception and object, yet the object is past and the perception is present!

Now if the object which I see, and see immediately, is one that existed before my seeing of it, it follows, in the first place, that there is a distinction between the object and the perception. Hence we find that the physiological argument confirms the analysis I made in my articles "The Stream of Consciousness" and "Prolegomena to a Tentative Realism."[10] There I found that a distinction must be made between consciousness and that of which we are conscious. Here we arrive at the same result: without this distinction all objects must have the time of the experience to which they belong, or of the perceptions of them, and must be tied down to this time. In the second place, since the physiological argument is based on facts that necessitate the priority of objects to the awareness of them, it follows that realism is correct in maintaining that objects are *temporally independent* of the awareness of them. *The argument proves realism, instead of disproving it.*

There is one remark that should be made before this examination of the physiological argument is concluded. We have seen that the realistic view commits one to the acceptance of the principle that in one sense consciousness is functionally dependent on physiological processes. Such a principle, we are told, is "absolutely incomprehensible."[11] "Their conjunction would simply have to be accepted

[9] This JOURNAL, Vol. I., pp. 521–522.

[10] This JOURNAL, Vol. IV., p. 225 ff., and p. 449 ff.

[11] Strong, "Why the Mind has a Body," p. 153.

as an ultimate fact.''[11] The realist is perfectly willing to accept it as an ultimate fact if thereby he is enabled to accept the other ultimate facts that the idealist seems so desirous of accepting, namely, that what we perceive is the very object itself, that there are various events that functionally mediate the object and the brain event with which consciousness is correlated, and that these events interpose a time interval between the date of the object and the date of the awareness. The realist finds it easier to accept ultimate facts than contradictions and fallacies and jugglings with perceptions which make the same perception now actual and now possible, now present and now past—legerdemain of the ''now you have it and now you haven't it'' kind. He has to accept ultimate facts sooner or later anyway, and he can not see how an ultimate connection becomes any the less ultimate when it is smuggled into a bag labeled ''similarities,'' wherein he is assured that one can ''begin to 'see the effect in the cause.' '' That bag seems rather to hide the ultimateness than to remove it.

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ATTENTION FATIGUE AND THE CONCEPT OF INFINITY

IT is the purpose of this paper to suggest a relation between the smothering or diffusion of attention found as one element of intellectual fatigue, immediate or cumulative, and the metaphysical concept of infinity in the sense of the unlimited and unconditioned.

In any concept we may have, of course, either purely word-images or images visual, auditory, kinesthetic, etc., of the object or of the relation or series of objects and relations. Let us call them content-images to distinguish them from word-images and from the secondary representations, visual, auditory, kinesthetic, etc., of word-images. Much of our thinking is carried on in terms of word-images or of the secondary representations of them. As in pure mathematics or in purely formal logic—such as the work of Peano, Schröder or Bertrand Russell—we can manipulate symbols, regardless of the content represented by these symbols, so in much of our ordinary thinking we make large use of merely word-images. But for any except this formal type of reasoning we have to use content-images. Thus if we examine discussions of the metaphysical concept of infinity, as in Spinoza or Kant, we find the use of something more than mere word-images. We find content-images. For instance, in Kant's first antinomy the whole discussion is based on an

attempt to analyze the content-images and to see how it is possible to think them in each case.

Having distinguished between content-images and word-images, and having seen that discussions of infinity involve content-images, let us see what is the nature of the content-images used. If we examine such as are actually used, we invariably find as one element such a form of the images that the attention is inevitably smothered. Let us quote as illustration from answers given to this question, "What images do you discover when you think of such abstract ideas as goodness, law, infinity, beauty, force, cause and effect?"[1] Those referring to the idea of infinity were as follows: "Space in a whirl," "A whirling, whirling ball," "Line extending through the sky," "Infinitely long, white straight line," "Space—blue, fluffy, misty clouds," "Mist-filled, colorless space extending forever and ever," "Space filled with subdued light, something like fog," "Sky at night with stars and milky way, etc." (several used images of sky in various forms), "Waves rolling on the beach," and several mathematical representations like "curve approaching Y-axis," "parabolas," "parallel lines," "circle." If we examine these, we find each of them involves an undifferentiated something as an invariable feature. Space is whirling, whirling so that its different positions are not fixed in attention; the line extends through the sky, long, white, unending, unchanging; the fluffy, misty clouds, the mist-filled, colorless space, the subdued light, all give as an invariable feature the very undifferentiated character which is sure to induce smothering of attention. The same is true of the waves rolling on the beach. That element in the image which represents the infinity is the fact that one wave follows another without change, the undifferentiated character of the process. Further examples could be added: "falling over the edge of the world into space,"[2] where the undifferentiated character appears in the succession of the imagined positions in the process of falling; the number series[3] considered as a process of manipulating digits, although this usually involves mere word-images. Kant in his first antinomy uses as the content-images a series of worlds, a repeated synthesis of parts, empty time and empty space,[4] in all of

[1] For the use of these answers I am indebted to Mr. W. V. D. Bingham, of the department of psychology, University of Chicago. This question was one of several relative to ideational type submitted to students in introductory psychology at that institution. I have made no attempt at quantitative results except as is involved in the statement that, so far as *any* content-images were found, they all had the element noted.

[2] Illustration of how a child gets the concept in Baldwin's "Dictionary of Philosophy and Psychology," Vol. I., article on "Infinite and Infinity."

[3] *Ibid.*

[4] *Cf.* "Critique of Pure Reason," Müller's translation, 2d Ed., pp. 344–347.

which the undifferentiated element is evident. The same is true of any self-representative series, of which form Professor Royce[5] has made so much. The baking-powder box having on its label a picture of itself and in this picture another picture of itself and so on is an example of such a self-representative series and shows the essential feature of that series to be, not the differences in the pictures, but the unvarying repetition of the series itself.[6] We find, then, in all the content-images cited, as an invariable element an undifferentiated character which is sure to smother attention.

Having found that this smothering of attention is an invariable element, we turn to inquire if it is not the essential element, if it is not the element by virtue of which these content-concepts are concepts of infinity, if it is not the element which, if lacking, would make the concept not a concept of infinity. We find that just in so far as we do have differentiation we say that we have not the concept of infinity. Thus in trying to form a content-concept of infinite time preceding the present moment, we may jump back over historical and geological periods, alighting momentarily on the thought of pyramid builders, of the first savages to use fire and stone implements, of the time the world was flung off from the hasty pudding of the sun and so on. There is, it is true, differentiation in this concept. There are alighting places for attention, but for that very reason we say that they do not even in combination represent infinity. The very fact that they can be differentiated and held in attention makes us say that they do not represent infinity. The more they can be differentiated, the more easily they can be held in attention, the less adequately do they represent to us infinity. The less differentiated they become, the more nearly they assume that character which shall smother attention, the more nearly we say they approximate the concept we are after. In these content-images cited, then, this smothering of attention is not only an invariable attendant, but also the essential element, that without which the concept would not be a concept of infinity. Since this smothering of attention is an essential element in these concepts, since we can not find any content-concepts in which this is not an essential element —although recognizing the inconclusiveness of this negative part of the argument—we are led to suggest that the concept of infinity is the metaphysical correlate of that which on the psychological side is smothering of attention. This smothering of attention is, of course, itself a symptom of certain molecular conditions of cortical and peripheral cells which we can at present but fragmentarily describe.

[5] "The World and the Individual," Vol. I., p. 501 ff.

[6] *Cf.* for further illustrations "The Infinite New and Old," J. A. Leighton, *Philosophical Review*, September, 1904.

One question may arise. If smothering of attention is the essential element in content-images of infinity, why does not every case of the smothering of attention give the concept of infinity? If we attend long enough to a single element of any image, for instance, the image of a desk-pad, we shall secure smothering of attention, but no concept of infinity. The answer, of course, is that in these latter cases the smothering of attention is one element of the process, but not the essential element. We do not say, in the case of the desk-pad, that the more undifferentiated our image of it becomes, the more nearly smothered our attention is, the nearer we are to a content-image of the desk-pad. But in the case of the concept of infinity we do say just this. The more undifferentiated the image the nearer it comes to being the concept of infinity. In short, the smothering of attention in the concept of infinity is the essential element, in the case of the concept of the desk-pad, an irrelevant attendant circumstance.

We have distinguished between two kinds of concepts, or images used as signs of bundles of experiences, word-images and content-images. We have seen that content-images are necessary for any description or argument, such as is found in the discussions of infinity by Spinoza and Kant. We have found that an invariable element in all content-images of infinity is an undifferentiated character sure to induce smothering of attention. We have pointed out that this smothering of attention is not only an invariable, but also an essential, element in the concept of infinity, and hence we have suggested that attention fatigue is the psychological correlate of the concept of infinity.

From this grow two or three other suggestions. One is relative to mystic states in which oneness with the infinite is such a prominent feature. As Pillsbury[7] has pointed out in the case of fluctuations of attention to minimal sensory stimuli, cumulative fatigue after a long period of work is likely to extend the periods of smothering of attention in immediate or temporary fatigue. In other words, when the organism is fatigued after prolonged nervous work or excitement we may expect the smothering of attention to be especially easy. In mystic states we find these very conditions of excitement and fatigue which would make the smothering of attention readily inducible. We find those conditions which would make the organism fallow for suggestions of the infinite.

A second suggestion is relative to a psychological interpretation of a well-known metaphysical position. Kant in his treatment of that field in which judgments involving infinity are in order, in his

[7] *American Journal of Psychology*, 1903, p. 541 ff.

treatment of the realm of things-in-themselves, says that they never can be known, but must be thought.[8] It is interesting to translate this observation into terms of physiological psychology. The infinite can not be known because knowledge involves the flitting of attention over the different features of any given percept or idea. Any attempt to know the content of the concept of infinity necessarily involves imagery sure to diffuse and smother the attention, and thus make knowledge of it impossible. By an automatic device attention is scattered and the knowing process stopped when turned to consider the concept of infinity. On the other hand, Kant says while it can not be known it must be thought, that is, these states of smothered attention are facts of experience and must be represented by concepts such as those of infinity and things-in-themselves.

The third suggestion is relative to an avenue of approach to questions of the physiological basis of metaphysics. It may be felt that the serious consideration of such questions in the present state of physiological psychology is foolhardy, that the problems of localization of function in the cortex and of the vicarious functioning of certain cortical centers for other cortical centers are at present too unsettled to allow of any such consideration, except, perhaps, as pipe-dreams of a psychologist after his regular day's work is done. But the foregoing study is just such a reaching out after a hint on the physiological processes underlying metaphysical concepts. We have tried to find out one of the psychological elements, namely, attention fatigue, which goes along with one type of metaphysical experience, namely, the concept of infinity. We have tried to reduce part of our problem to terms of attention fatigue. But the problem of the physiological basis of attention fatigue does not seem entirely hopeless to the physiological psychologist.[9] This problem seems to offer him a handle as that of the physiological basis of a metaphysical concept does not. If we can establish a relation between the concept of infinity and attention fatigue we may be able to use some of the experimental data on the physiological correlates of attention fatigue to help in the larger problem. We recognize, then, that in speaking of this concept in terms of attention fatigue we are speaking in terms of a psychological symptom of a physiological state, of the precise nature of which physiological state we are still largely ignorant. We see, however, that if we establish a relation between the concept of infinity and attention fatigue this relation will not be disturbed

[8] *Op. cit.*, p. 207 ff.

[9] *Cf.*, besides the works of Wundt, Münsterberg, Lange and others on fluctuations of attention, W. MacDougal on the "Physiological Factors of the Attention Process," *Mind*, Vols. XXVII., XXVIII.

by further light on the molecular changes underlying attention fatigue. This relation will put us a step nearer discovering the physiological basis of one metaphysical concept.

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REVIEWS AND ABSTRACTS OF LITERATURE

Plant Breeding. Comments on the experiments of Nilsson and Burbank. HUGO DEVRIES. Chicago and London: The Open Court Publishing Co. Pp. vi + 360.

This work of deVries's is primarily devoted to an exposition of the methods followed by Nilsson and Burbank, but of equal importance and interest is the attention that is given to his theory of evolution and mutations.

The work of Nilsson, which will revolutionize plant breeding and open fields of scientific investigation of fundamental importance, has heretofore been concealed from the public owing to the fact that he has entirely disregarded all educational aims and purely scientific researches. His sole effort has been directed to the amelioration of agricultural crops, but it should be added that his work is based upon the most exact and scientific methods. This report of deVries's will bring amazement when it is learned that in the little Swedish village of Svalöf, opposite Copenhagen in Denmark, results have been obtained and principles have been discovered during the past fifteen years which exceed in importance all the achievements in agricultural history.

This work was started owing to the slow but manifest deterioration of various agricultural crops, which lessened the value of the harvests in an important degree. A few Swedish farmers formed a company in 1886 at Svalöf for the purpose of procuring and testing new foreign varieties of seeds in order to replace the inferior Swedish varieties. Naturally, the German method, which was most widely practised at that time, of improving the quality of the grain, was followed. The practise was to select numerous examples of the best specimens of a particular crop, *i. e.*, make a "multiple selection," and this *élite* stock was sown, and similar selections were again made from it. Year after year the best examples were chosen from the successive crops, and slowly and gradually the qualities were supposed to improve in the direction desired. While important additions were made by this method to several varieties of grains during the early history of the company, a more important fact became obvious, that success was the exception, and it soon became a demonstration that the old idea of the arbitrary control of the qualities of a plant was manifestly untrue. It became evident that the plant develops after its own nature and can not be forced into other ways.

It was at about this period in the history of the work (1890) that

Nilsson became director. His thorough knowledge of the laws of variability and inheritance led him early in his work to the remarkable discovery that each so-called variety of grain really embraced a protean group of types, that is, each cultivated species was made up of numerous elementary species. Five hundred such species have been separated from the common peas, and all the cereals were found to contain several hundred. So the first problem in plant breeding was not the multiple selection of the German method, which would in all probability result in associating numerous elementary species, but rather the selection of a particular plant or elementary species. With this idea in mind about two thousand divergent types were gathered, in 1892, and the grains from each mother plant were sown in separate plots. The results exceeded all expectations. Barring chance hybrids and mutants, all the plots showed offspring of exceptional uniformity. For example, of 422 plots of oats 397 were uniform and only 25 were multiple. Furthermore, an examination of the pure types, in 1893, showed that their mutual differences were much greater than could have been surmised from the amount of variability in the field at the time of the selection. More important still, these types were found to comply with the most diverse requirements, some were highly resistant to frosts, others to disease, some were suited for hard land, and others for light soil; they differed in stiffness of culms, length of ears, size and number of grains, etc. In a word, hardly any demand could be pointed out which at least one of the new varieties did not meet.

Scarcely less important than this remarkable discovery was Nilsson's methodical study of the association of plant characters. While the relationship between the morphological characters of the plant and its qualities has been recognized in a degree for a long time (indeed, this is the basis of practically all of Burbank's work), it remained for the Svalöf station to demonstrate the intimate relation or correlation between plant characters and qualities—a principle of the greatest practical value. As soon as it was established that any field of grain contains a great many types so widely variable as to furnish suitable stock for the most different conditions, the need was felt for a method to enable the breeder to make the desired selection. Study along this line showed that numerous apparently insignificant characters remained fairly consistent in the successive sowings, and so offered a reliable means of distinguishing strains of widely divergent practical value. The problem then was to classify these characters and correlate them with their agricultural qualities. A compilation was begun, and a system has slowly been elaborated for many of the cereals, peas, vetches, etc., so that when a particular quality is desired in any of these plants in order to bring it into a form suitable for other conditions of soil or climate, or to comply with any want of the breeder, it is only necessary to know the marks associated with the desired quality in order to select a stock that will meet the required demands. In a word, these studies demonstrated that there is a regular coincidence of characters which hitherto have been regarded as

quite independent from one another. Furthermore, this association of characters was shown to obey natural laws, and a study of these laws enabled the breeder to predict a quality from the observation of one or several characters. The result of the work of the station is seen in the rapid improvement of the crops and in the certainty and directness of the results obtained. Thus in 1901 eighteen excellent new types were made available, a sharp contrast to the German method where twenty years of the most careful selection were well spent if a single new form was secured.

DeVries has made full use of this work in fortifying his mutation theory. Owing to the elaborate system of bookkeeping, every quality and character of a variety was recorded. As a consequence any deviation in the offspring from the mother plant became manifest at its first appearance. The records of the station show that several variations appeared from time to time that correspond with deVries's idea of a mutant. They always appeared suddenly, they could be separated from the other plants in the same way as the elementary species, and they were constant in the transmission of their new characters. But of much more importance to deVries is the light that this work throws upon the work of Rimpau and other breeders, who by years of careful breeding gradually so ameliorated the races of rye and other cereals (so they believed) as to produce a highly superior variety. Darwin was greatly influenced by this commonly accepted belief of breeders and applied it to his views on evolution, assuming that similar gradual changes went on in nature, and so led to the slow creation of species by a gradual, imperceptible series of changes. The so-called creation of new varieties by breeding has been a serious argument against the mutation theory and one that it has been impossible to answer until the results of Nilsson and other workers were available. It can not be questioned that the old breeders achieved success by a chance separation of a pure stock after years of haphazard selection. The work of Svalöf demonstrates that but a single initial selection of an elementary species is necessary, and it only remains to multiply and test the exact value and worth of the form by breeding it for a few years. Any further selections are of no avail in modifying the qualities of the selected species. We regret that the author has not discussed the continuous variations of these mutants; possibly the records of the station do not furnish, as yet, the necessary data upon this point. The main contention regarding the validity of the mutation theory is now reduced to this, Do the curves of continuous variation of the parent and mutant overlap? If not, deVries has established his theory; if they do, he has yet to prove that the mutant is not an extreme of continuous variation.

While much false and misleading information has been published regarding the work of Burbank, sufficient fairly accurate accounts of his accomplishments have been written to make his methods and achievements familiar to all. Mr. Burbank is an idealist; he is not concerned with the purely scientific aspects of horticulture, but is actuated solely

by a desire to contribute to the welfare of his fellow men. No better measure of the man could be given than his dream of developing a spineless cactus that by its adaptability to arid conditions and its edible qualities would make possible the doubling of the population of the world. He has no desire to accumulate wealth; as soon as his novelties are proven fit they are sold and their propagation and distribution is left to dealers. Thus it was with his first hybrid, in 1873—the Burbank potato. This was sold to a seed firm in 1875 for $125. The Department of Agriculture a few years ago estimated that this potato had added to the agricultural productivity of the country $17,000,000. It is safe to state that these figures will appear of little moment when as long a period has been given for the introduction of his recently derived berries, plums, walnuts, etc.

Mr. Burbank is little concerned with the amelioration of a race, and in this respect his work is quite different from that of the Svalöf station. His results in plant breeding have largely been obtained by hybridizing. Crossing of plants upsets the constancy of the species, brings them into a state of unstable equilibrium, and produces a chaos of forms. From these forms any of value are selected. Thus his methods have been perfected along the lines that have been followed since the beginnings of horticultural practise. Burbank, however, excels all other breeders in two respects. He starts with as many promising species as possible. Thus in his callas, five new types were added at once by a series of crossings with the familiar white kind; so also with his improvement of the California tiger lily, many of the lilies of the world have contributed their peculiarities for the enrichment of the native form. An idea of the extent of the material with which he works may be gained from the fact that he has had under cultivation 2,500 distinct species.

It is commonly believed that these improved forms are new creations. Hybridizing introduces into the offspring a new association of characters. No new characters are added. Every novelty has its basis in some previously existing form. The stoneless prune was derived from numerous crossings of a worthless French prune, *prune sans noyau,* with the ordinary varieties. This stoneless prune was known two centuries ago and had since been cultivated as a curiosity. Burbank saw the possibilities in associating its stoneless character with the flavors, colors, and meat of other forms. Crossings and selections have already isolated one stoneless form for the trade, with prospects that all the present varieties will finally be blended with the stoneless trait.

Mention can only be made of the excellent résumé of the mutation theory and of the important discussion to American farmers of corn breeding. Several features in the closing chapters on plant distribution will be taken with more or less reservation by many. The discussion of the principles of adaptation, however, are most timely. He very justly characterizes the attempts to explain the larger groups of characters of organisms as the expression of relationship with special features of the environment as "merely poetical descriptions of the way in which

we should like to understand and admire nature." We can not refrain from noting that the author occasionally drops into the realm of poetry, as when he refers to plants remaining on the mountains owing to their dread of enemies in the valley (p. 340), or when he speaks of plants seeking conditions (p. 335).

This book is one of the most valuable contributions to botanical science that has appeared in recent years. It will be widely read because of the clear scientific discussion of the principles that underlie plant breeding.

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A Primer of Psychology. LAURA BRACKENBURY. London: John Murray. 1907. Pp. 120.

The author expresses, in her preface, her special indebtedness to Professors Ward, Stout, and Johnson, of Cambridge University, and Professor James, of Harvard. Her technical point of view will be fairly familiar to those who have read the first two writers mentioned. An introduction gives some timely suggestions to the beginning student. Then the various methods of psychological study are presented and evaluated; it is maintained that the direct method must have logical and temporal priority. Next comes the "general analysis of mind," in which the *a priori* concept of the subject-object relation is made fundamental and its three phases are used to define the three classes of mental phenomena—cognition, affection (including pleasure-pain and appetition-aversion), and attention, or activity. There follow four chapters on the several stages of cognition: sensation, perception, imagination, and ideation. The subject of cognition is given quite half the space of the text, but its divisions, sensation and perception, are given relatively brief treatment, the usual details on their special modes and forms being omitted. The more fundamental laws of mental complication and unification are developed under perception and imagination; conditions of origin and growth of higher forms receive some attention; and the function of the universal and of the word is not omitted. Attention is viewed as activity of varying degrees, not as mere focalization. The discussion of how pleasure-pain is conditioned by each of the four stages of cognition is along quite traditional lines, physiological explanations being omitted. One of the most successful chapters in the book is that in which James's theory of emotion is described and criticized; emotion is found to contain an ideational factor. Will as selective action has its root in impulse; a good analysis of an act of will is given.

Following the text is a glossary which is rather unsatisfactory; for it is often formal to the point of emptiness, or its definitions fail really to define (*e. g.*, affection, ideation, mind). Then come some questions and exercises. These (especially the general questions in preference to those arranged by chapters) will be useful alike to teachers and students; and particularly those questions (of which there is a good proportion) that

call for a psychological interpretation either of literary passages or of concrete experiences and situations.

The book's point of view is both structural and functional, with the emphasis on the former. Purpose, need, and interest are frequently employed categories; but the author's neglect of the biological point of view involves a limitation in explanation by purpose. A sharp distinction is made between the psychological and the physical or physiological. The attempt is made to exclude all but psychical phenomena and conditions; but at some points it becomes impossible not to dwell upon physical or physiological conditions or concomitants, as in the cases of sensation, feeling, emotion, and will.

The principal terms are given rather clear-cut interpretation in the body of the text; their various meanings in psychology and common life are distinguished. Further, the author is careful to point out the relations (of likeness and difference, or of causal connection) that maintain between the various types of mental phenomena studied. A good deal of precision in the organization of the material is evident. In these and other ways the student's probable difficulties are kept in mind and attempt is made to guard him from error.

Comparatively speaking, however, this primer is a bare outline; its illustrations, while timely and clear, are too few; and it must be often hard for any beginning student to understand—witness much of the subject of cognition, particularly ideation and pp. 33–35 on perception. It is packed full of boiled-down material; it contains, perhaps, more distinctions than are needed; but it wants expansion and variety of illustration. I have just called it a "bare outline." To one who knows some psychology it might be rich in suggestion as well as compelling in its organization of material, but many a novice will find it formal and dreary.

When we consider under what conditions students really find an outline or syllabus prepared by their teacher useful, it is evident that this depends upon (*a*) the nature of the outline, (*b*) whether it is used before or after the class exercise mainly, and (*c*) whether or not it is supplemented by concrete collateral reading. The text here discussed would seem to be best adapted for use as a summary statement of data and views previously collected, and already presented and discussed in the classroom. It presupposes plenty of strong oral teaching as well as collateral readings. In this connection the references, at each chapter's close, to James, Stout, and Ward will be of use; for if these sources are few and lacking in great variety, they are yet relevant to the point of view and scope of the primer.

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Die Moralphilosophie von Tetens. Zugleich eine Einführung in das Studium der Ethik. Max Schinz. Leipzig: B. G. Teubner. 1906. Pp. vi + 152.

Dr. Schinz believes that posterity will give Tetens a place among the

greatest moral philosophers. The worth of his ethical system has not been recognized as yet, partly because it was left in scattered and fragmentary form, and partly because it was overshadowed by the great work of Kant appearing soon after. The author of the present essay aims to remove the first hindrance by presenting Tetens's moral philosophy in its systematic entirety. In the first part of the book the psychological basis of the theory is given in detail; in the second the doctrine of moral values is explained. As Störring proves that Tetens's epistemology is a synthesis of Hume and Leibniz, so our author shows that his moral philosophy is a union of certain tendencies in English ethics with the rationalistic principles of Leibniz. Two grades of virtue are distinguished. The higher, which has absolute value, consists of complete self-mastery. It is the essence and perfection of virtue. In it the will rises supreme over all desires and emotions, and subordinates them to its rule of duty. In this ideal of absolute virtue we detect the influence of the Leibnizian philosophy. All absolute worth in man is a quality of soul because soul alone in human nature has incorporeal unity and thus is truly real. Hence the greater the strength and spontaneity of soul in man, the greater his reality. That faculty in the soul which possesses most spontaneity, viz., the will, has greatest worth and hence in its perfect freedom lies absolute virtue. The lower form of virtue, which has only relative value, is that of kindness of disposition. Here the desires and impulses are of such a nature and so adjusted that the conduct of the individual tends to increase his own happiness and that of his fellow-men. In this disposition the feeling of sympathy is the controlling factor. In his emphasis upon the principle of sympathy and his account of its development Tetens shows the influence of Hume and English ethics.

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La logique et l'intuition en mathématiques. E. Borel. *Revue de métaphysique et de morale,* May, 1907. Pp. 273–283.

The author seeks an appropriate view of invention and discovery in mathematics, and aims to assign to this phase of mathematics its proper place in teaching the subject.

The importance of a knowledge of the principles of mathematics in the development and progress of the science proper has been grossly exaggerated. This exaggeration results in an erroneous impression upon some students that the whole realm of mathematics is controlled by deductive logic. The contention of the author is that the peculiar function of mathematics consists in the invention and discovery of analytic facts and the laws which govern their relationships. For such discovery Borel finds that the knowledge of the principles is not essential.

The material for the science of mathematics is derived from logic in quite the same way that the physicist obtains his objects of inquiry from nature. Logic gives to mathematics a great number of formulas and

propositions. From these the mathematician chooses the fundamental notions for his constructions. Indeed the work of the science proper begins when the mathematician makes this selection of certain formulas and relates them according to general theories. But one does not say that the natural objects of the physicist are the science of physics. Neither should we say that the formulas contributed by logic constitute the science of mathematics. This distinction of the principles of mathematics from the mathematical science proper is essential to Borel's point of view.

The peculiar work of mathematics, as stated above, consists of invention and discovery, which is, as will be shown later, more intuitive than deductive. For invention in mathematics is precisely what it is in any other science. The discovery, by Newton, of universal attraction was simply a new way of explaining given facts. Just so mathematical discoveries are merely new ways of explaining known facts. So that, in this particular, logic does not play any greater part here than it does in any other science.

To make clear his meaning of mathematical invention and to show what part logic plays in actual mathematical constructions, the author cites a number of examples from the different branches of mathematics. The following are typical of all the illustrations given:

Given four points, A, B, C, D, on a straight line Δ, a point O not in Δ, and Δ' another straight line not passing through O. Join OA, OB, OC, OD which meet Δ' in A', B', C', D', we shall then have:

$$\frac{CA}{CB} : \frac{DA}{DB} = \frac{C'A'}{C'B'} : \frac{D'A'}{D'B'}$$

This is a simple theorem in geometry. Its proof has been known for a long time. But to discover in this theorem the theory of an harmonic ratio and its numerous consequences required the genius of Chasles. Instead of being a simple theorem in geometry it becomes the fundamental notion of projective geometry. To make this discovery no deductive logic was required. It was made precisely as discoveries are made in the natural sciences. Nor did the new discovery invalidate the old theorem of geometry. It merely presented a new way of explaining the given facts.

The shortcomings of logic to explain the whole of mathematics is clearly and forcibly shown when we examine two orders of inquiry apparently different in character between which a close correspondence has been established. When Klein finds that the study of the regular icosahedron simplifies to a considerable extent the algebraic theory of the equation of the fifth degree, and that, furthermore, this correspondence throws light on the study of the differential equation of the second order, one sees clearly that the discovery was not the result of deductive methods solely.

Again, if we examine certain general theories of mathematics we

shall find here also that logic does not occupy the entire field. Thus the theory of the functions of the complex variable is developed in two distinct ways. Weierstrass develops the theory deductively, while with Riemann the geometric representation of the complex variable is essential. Thus the intuitive character of even such an abstract theory is evident.

The article closes with a plea for more adequate pedagogic methods in the teaching of mathematics. From the point of view of the student, the chief aim has been to develop the logical faculty. While this is not to be neglected, Borel would introduce such methods as would foster mathematical inventiveness with the aim of developing the mathematical ability to discover analytic facts and the laws governing their relationships.

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JOURNALS AND NEW BOOKS

REVUE PHILOSOPHIQUE. August, 1907. *La cryptopsychie* (pp. 113–144): E. BOIRAC. – This is a study of both fragmentary and organized unconscious psychic processes with reference to the mental phenomena which they explain and to their own explanation. *Herbert Spencer d'après son autobiographie* (pp. 145–158): F. PAULHAN. – A synopsis of the autobiography of Herbert Spencer as translated and abridged by Henri de Varigny. *Le rôle de l'analogie dans les représentations du monde extérieur chez les enfants* (pp. 159–173): R. COUSINET. – The common theory that the child perceives analogies in his experiences because he needs them is incorrect. He perceives analogies before perceiving differences, but with increasing maturity differences become more easily perceived. *Analyses et comptes rendus:* F. Paulhan, *Le mensonge de l'art:* P. SOURIAU. H. Riemann, *Les eléménts de l'esthétique musicale:* L. DAURIAC. J. Baruzi, *Leibniz et l'organisation religieuse de la terre:* A. PENJON. H. Siebeck, *Zur Religionsphilosophie:* J. SEGOND. M. J. Lagargette, *Le rôle de la guerre:* S. JANKELEVITCH. Kropotkine, *L'entr'aide:* G.-L. DUPRAT. A Prins, *De l'esprit du gouvernement démocratique:* JANKELEVITCH. Mariano Mariani, *Il fatto cooperativo nell' evoluzione sociale:* G.-L. DUPRAT. Fanciulli, *L'individuo nei suoi rapporti sociali:* G. RICHARD. C. Piat, *Platon:* C. HUIT. *Revue des périodiques étrangers.*

REVUE PHILOSOPHIQUE. September, 1907. *Les conséquences morales de l'effort* (pp. 225–247): G. TRUC. – Effort is the spring and support of all morality as well as the source from which it gets its whole value. *L'ordre des sciences* (2e et dernier article) (pp. 248–271): F. LE DANTEC. – This paper shows the needs that lead us to take "energy" as the invariant of our changing world when we found an "impersonal" science. *L'imitation dans l'idée du moi* (pp. 272–281): J. PAULHAN. – Our idea of the "I" is the application to our feelings and ideas of a form

borrowed from others. *Notes et discussions: Sur un cas de paramnésie* (pp. 282–284): L. BÉLUGOU. *Explication ou expression: Critique des théories psychologiques* (pp. 284–287): HENRI PIÉRON. *Analyses et comptes rendus:* G. Papini, *Il crepusculo dei filosofi:* A. L. Eucken, *Hauptprobleme der Religions philosophie der Gegenwart:* L. ARRÉAT. Sollier, *Essai critique et théorique sur l'association en psychologie:* L. DUPUIS. Binet, *L'année psychologique:* B. BOURDON. Sternberg, *Charakterologie als Wissenschaft:* L. ARRÉAT. Faguet, *Le socialisme en 1907:* G.-L. DUPRAT. Dubief, *A travers la législation du travail:* G. RICHARD. *Revue des périodiques étrangers.*

Hart, Gordon. *Woman and the Race.* Westwood: The Ariel Press. 1907. Pp. 264. $1.

Kellogg, Vernon L. *Darwinism To-day.* New York: Henry Holt & Co. 1907. Pp. xii + 403. $2 *net.*

Papini, Giovanni. *Il pilota cieco.* Naples: Riccardo Ricciardi. 1907. Pp. 200. 3 lr.

Riley, I. Woodbridge. *American Philosophy: The Early Schools.* New York: Dodd, Mead & Co. 1907. $3.50 *net.*

Rogers, Arthur Kenyon. *A Student's History of Philosophy.* Revised edition, 1907. New York: The Macmillan Co.; London: Macmillan & Co. Pp. vii + 511.

NOTES AND NEWS

FROM *Nature* for September 12 we take the following: "The third volume, which deals with linguistics, of the Reports of the Cambridge Anthropological Expedition to Torres Straits has now been published by the Cambridge University Press. The volume is by Mr. Sidney H. Ray, and consists of four parts, dealing respectively with the languages of Torres Straits, the languages of Cape York Peninsula, North Queensland, the languages of British New Guinea, and the linguistic position of the languages of Torres Straits, Australia and British New Guinea. . . . The following general linguistic summary gives the results of Mr. Ray's work on the material collected by himself and Dr. A. C. Haddon with the assistance of numerous other workers: (1) The western language of Torres Straits is Australian. (2) The eastern language of the Straits is morphologically related to the Papuan of New Guinea. (3) There is no genealogical connection between the two languages of the Straits. (4) There is no evidence of an African, Andaman, Papuan or Malay connection with the Australian languages. There are reasons for regarding the Australian as in a similar morphological stage to the Dravidian, but there is no genealogical relationship proved. (5) The Papuan languages are distinct from the Melanesian. They are in some respects similar to the Australian, but their exact positions are not yet proved. (6) Languages of the Papuan type are found in German New Guinea. There is no

direct evidence of their existence in Netherlands New Guinea. (7) There is insufficient evidence to connect the Papuan with the Andaman or Halmaheran languages. (8) In the northern Melanesian Islands a few languages are found which have Papuan characteristics. (9) Differences of grammar and vocabulary which appear in other island languages appear to be remains of an archaic Melanesian speech. There is no grammatical evidence to connect them with the Papuan, but they show the Papuan diversity of vocabulary. (10) The Melanesian languages of New Guinea and those of the islands are closely (genealogically) related in grammar and vocabulary. (11) The Melanesian languages of New Guinea and the islands stand in the same position with regard to the Polynesian. Both the former represent an older and fuller form of speech of which the Polynesian is a later and more simplified descendant."

A COURSE of lectures is to be given in Columbia University during the current academic year with the special purpose of offering to the students of the University a general view of the entire outlines of modern knowledge and a definite conception of the province and problems of each of the sciences and of its relations to other sciences. By means of such a course it is hoped to offset in some degree the effects of the specialization inevitable in present-day university study, and to make it at least possible for all who leave the University to carry with them some sense of the unity of knowledge, and of the correlation and interdependence of its several provinces. The lectures, which are open to the public, are given on Wednesdays, beginning October 16. The program is as follows: Mathematics, Cassius J. Keyser; Physics, Ernest Fox Nichols; Chemistry, Charles F. Chandler; Astronomy, Harold Jacoby; Geology, James Furman Kemp; Biology, Edmund B. Wilson; Physiology, Frederic S. Lee; Botany, Herbert M. Richards; Zoology, Henry E. Crampton; Anthropology, Franz Boas; Archeology, James R. Wheeler; History, James H. Robinson; Economics, Henry R. Seager; Politics, Chas. A. Beard; Jurisprudence, Munroe Smith; Sociology, Franklin H. Giddings; Philosophy, Nicholas Murray Butler; Psychology, R. S. Woodworth; Metaphysics, Frederick J. E. Woodbridge; Ethics, John Dewey; Philology, A. V. W. Jackson; Literature, Harry Thurston Peck.

A JAPANESE translation of Professor Warner Fite's "Introductory Study of Ethics" by N. Oshima, revised by Professor Rikizo Nakashima, of Tokyo University, has recently been published.

MR. F. N. FREEMAN, assistant in the Yale psychological laboratory, is to substitute for Professor Gault in psychology and education during the fall term at Washington College, Chestertown, Maryland.

PROFESSOR GEORGE SANTAYANA, assistant professor of philosophy at Harvard University, has been made professor of philosophy.

DR. ERNEST ALBEE, assistant professor of philosophy at Cornell University, has been made professor of philosophy.

DR. G. W. T. WHITNEY, of Bryn Mawr College, has been made instructor in philosophy at Princeton University.